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Combining like terms, we have

$$t^{k+1}-(t-1)^k[t(k+1)-k+t-2]+\cdots+(-1)^{s-1}(t-s+1)^k\binom{k+1}{s-2}$$
$$\times\left[t\frac{k-s+3}{s-1}-k+t-2\right]+\cdots+(-1)^{t-1}\binom{k+1}{t-2}\left[t\frac{k-t+3}{t-1}-k+t-2\right],$$

which reduces to the left member above:

$$t^{k+1}-(t-1)^{k+1}\binom{k+2}{1}+\cdots+(-1)^{s-1}(t-s+1)^{k+1}\binom{k+2}{s-1}+\cdots$$
$$+(-1)^{t-1}\binom{k+2}{t-1}.$$

If we replace k by $k-1$ we shall have the tth term in $F_{k-1}(r)$. Hence we have the desired formula for $S_{k,r}$:

$$S_{k,r}=\sum_{n=1}^{\infty}\frac{n^k}{r^n}=\frac{r}{(r-1)^{k+1}}\Bigg\{r^{k-1}+[2^k-(k+1)]r^{k-2}+\cdots$$
$$+\left[t^k+\cdots+(-1)^{s-1}(t-s+1)^k\binom{k+1}{s-1}+\cdots\right.$$
$$\left.+(-1)^{t-1}\binom{k+1}{t-1}\right]r^{k-t}+\cdots+1\Bigg\}.$$

The general series of the introductory paragraph may now be written

$$T=\frac{b_0}{a}S_{k,r}+\frac{b_1}{a}S_{k-1,r}+\cdots+\frac{b_r}{a}S_{0,r}.$$

BOOK REVIEWS.

Memorabilia Mathematica. By ROBERT EDOUARD MORITZ. vii+410 pages. The Macmillan Co., New York, 1914. $3.00 net.

In the Memorabilia Mathematica we are presented with a collection of more than 1100 quotations pertaining to many phases of mathematics and to the life and thought of mathematicians. The page preceding the title page is graced by two quotations from Goethe and Emerson. They read: "Alles Gescheite ist schon gedacht worden; man muss nur versuchen es noch einmal zu denken," and "A great man quotes bravely, and will not draw on his own invention when his memory serves him with a word as good."

We may safely infer that in these quotations, if not interpreted too literally, the author expresses a conviction and implies a purpose. The intrinsic value of the ideas expressed in the Memorabilia shows that the author's conviction is well founded. His purpose is realized in bringing this wealth of ideas within easy reach of mathematical and non-mathematical students.

The volume presents a great range of subjects. It deals not only with the nature and value of mathematics, with the relation of mathematics to logic, philosophy, and science, and with mathematics as a fine art and as a language; but it also introduces a strong personal, human element and deals with the mathematician. In a work of this kind we expect to find many mathematical authors quoted; but are hardly prepared to meet, in addition to the mathematical authors, the names of many men famous in other walks of life. But such is the case. We meet Benjamin Franklin and Daniel Webster, John Locke and Francis Bacon, Goethe and Froebel, Napoleon and Voltaire, and many others.

The book is very suggestive and stimulating. Many viewpoints that are presented contain a challenge to the thinking mind. In dealing with the nature of mathematics we thus find, from the pen of Klein, "Mathematics is fundamentally the science of self evident things," to which Pringsheim replied: "For the majority of the cultured, even of scientists, mathematics remains the science of the incomprehensible." The remark of Huxley certainly contains a challenge: "Mathematics is that subject which knows nothing of experiment, nothing of induction, nothing of causation."

In the light of the fact that mathematics is often spoken of as the science that deals largely with logical processes, and that draws necessary conclusions, the following from Voltaire is significant: "There is an astonishing imagination, even in the science of mathematics. . . . We repeat, there was far more imagination in the head of Archimedes than in that of Homer." From another writer, bearing on the same subject and emphasizing other qualities than that of logic, comes the dictum: "The whole of mathematics consists of a series of aids to the imagination in the process of reasoning." Keyser introduces us to a significant, interesting encounter: "When the greatest of American logicians, speaking of the powers that constitute the born geometer, had mentioned conception, imagination, and generalization, he paused. Thereupon from the audience there came the challenge, 'What of reason?' The instant response, not less just than brilliant, was: 'Ratiocination—that is but the smooth pavement on which the chariot rolls.'"

The Memorabilia has rendered a real service in presenting quotations of sufficient length to illuminate and give a setting for ideas, which, without such a setting, are incomprehensible and misleading. Thus the quotation of Russell, at times quoted with startling effect, that "Mathematics may be defined as the subject in which we never know what we are talking about, or whether what we are saying is true," might be taken as that of a cynic or an iconoclast; but the Memorabilia presents this and other passages with enough of the context, so that they come to us as significant, constructive contributions.

The Memorabilia also presents us with many a human touch, and throws a light, not to be found in purely mathematical books, on many well known men. To take but one case, let us consider Newton for a moment. We find

> "Nature and nature's law lay hid in night:
> God said, 'Let Newton be!', and all was light."

and

> "A monument to Newton! A monument to Shakespeare! Look up to heaven—look into the Human Heart. Till all the planets and the passions—the affections and the fixed stars are extinguished—their names cannot die."

In contrast to this, on the other hand, we are told that Newton "could not readily make up a common account: and, when master of the mint, used to get somebody else to make up his accounts for him." Another side light is the mention of his relation to astrology. "There was a time when Newton was possessed with the old fooleries of astrology; and another when he was so far gone in those of chemistry as to be upon the hunt after the philosopher's stone."

Of the modesty of this great man we are told "If I have seen farther than Descartes, it is by standing on the shoulders of giants." And again: "Newton could not admit that there was any difference between him and other men, except in the possession of such habits as . . . perseverance and vigilance. When he was asked how he made his discoveries, he answered, 'By always thinking about them'; and at another time he declared that if he had done anything, it was due to nothing but industry and patient thought: 'I keep the subject of my inquiry constantly before me, and wait till the first dawning opens gradually, by little and little, into a full and clear light.'"

The devotees in many ages have sounded the praises of mathematics. From Euripides the Memorabilia presents us with this contribution: "Mighty are numbers, joined with art resistless"; and from Plato comes a passage that contains a claim for arithmetic which has been heard for mathematics in general in more modern days, for we read: "No single instrument of youthful education has such mighty power, both as regards domestic economy and politics, and in the arts, as the study of arithmetic. Above all, arithmetic stirs up him who is by nature sleepy and dull, and makes him quick to learn, retentive, shrewd, and aided by art divine he makes progress quite beyond his natural powers." Another note of praise is sounded in the words: "If the Greeks had not cultivated Conic Sections, Kepler could not have superseded Ptolemy; if the Greeks had cultivated Dynamics, Kepler might have anticipated Newton."

The relation of mathematics to our every day experiences is expressed in such passages as the following: "Mathematics, the science of the ideal, becomes the means of investigating, understanding and making known the world of the real." And again: "Geometry in every proposition speaks a language which experience never dares to utter; and indeed of which she but half comprehends the meaning. Experience sees that the assertions are true, but she sees not how profound and absolute is their truth. She unhesitatingly assents to the laws which geometry delivers, but she does not pretend to see the origin of their obligation. She is always ready to acknowledge the sway of pure scientific principles as a matter of fact, but she does not dream of offering her opinion on their authority as a matter of right; still less can she justly claim to herself the source of that authority."

A delicious humor is found in many passages. I wish to give but a single example from De Morgan. "German intellect is an excellent thing, but when a German product is presented it must be analyzed. Most probably it is a combination of intellect (I) and tobacco-smoke (T). Certainly I_3T_1, and I_2T_1 occur; but I_1T_3 is more common, and I_2T_{15} and I_1T_{20} occur. In many cases metaphysics (M) occurs and I hold that $I_aT_bM_c$ never occurs without $b+c>2a$.

N.B.—Be careful, in analyzing the compounds of the three, not to confound T and M, which are strongly suspected to be isomorphic. Thus, $I_1T_3M_3$ may easily be confounded with I_1T_6. As far as I dare say anything, those who have placed *Hegel, Fichte*, etc., in the rank of the extenders of *Kant* have imagined T and M to be identical."

I have quoted freely from the volume under review, hoping thereby to convey something of the atmosphere that pervades it; but I realize fully that no limited number of quotations can adequately suggest the wealth and variety of ideas that it presents to the reader.

The author was very happy in the selection of material in this pioneer work, and has rendered a service to mathematical and non-mathematical readers.

The value of the work is greatly enhanced by the author's success in giving exact references to the quotations used, for in this way the Memorabilia becomes a guide to a much larger range of material "pertaining to mathematics, by poets, philosophers, statesmen, scientists, and mathematicians."

An excellent cross reference index of some 700 topics makes the material gathered very accessible.

GEO. N. BAUER.

PROBLEMS AND SOLUTIONS.

B. F. FINKEL, CHAIRMAN OF THE COMMITTEE.

PROBLEMS FOR SOLUTION.

ALGEBRA.

When this issue was made up solutions of 412 to 421 had been received. A solution of 406 is desired.

422. Proposed by W. D. CAIRNS, Oberlin College.

Find a solution of the equation $x^{x\sqrt{x}} = (x\sqrt{x})^x$.
(Adapted from Godfrey & Siddon's *Elementary Algebra.*)

423. Proposed by ELBERT H. CLARKE, Purdue University.

Show that the following formula is true for all positive integral values of k. The parenthetical symbols are defined as being the binomial coefficients. $\binom{k+1}{0} = 1$, by definition.

$$k^k\binom{k+1}{0} - (k-1)^k\binom{k+1}{1} + (k-2)^k\binom{k+1}{2} + \cdots$$
$$+ (-1)^{s-1}(k-s+1)^k\binom{k+1}{s-1} + \cdots + (-1)^k\binom{k+1}{k-1} = 1.$$